Quality Requirement

Electrical Assembly General Requirements

RIG/PLANT		
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REMARKS		
MAIN TAG NUMBER		DISCIPLINE
CLIENT PO NUMBER		
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REVISION HISTORY

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CHANGE DESCRIPTION

Revision	**Change description**
3	Revised section 2.1 with updated reference standards
	Revised section 4.4 with correction on IE/ISE bar information
2	Revision to update system metadata
	No content change
1	Overall revision
0	

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1 PERSONELL GENERAL QUALIFICATIONS

Assembly of electrical installations and equipment in hazardous areas must be done by **electrical skilled workers**, **competent persons** or **instructed personnel** who have completed an EX course or has knowledge in working with EX installations.

Electrical Assembly shall be performed by skilled personnel that have passed applicable documented training and/or certifications related to electrical or instrumental installations.

Valid and approved trainings can be considered but not limited to:

- FSE or equivalent
- Ex-installation courses

Training of personnel shall be relevant to the voltage bands applicable for the installation. (high and low voltage installation competence).

These requirements are applicable for new manufacturing as well as re-building/repair and servicing of equipment.

All work to be performed by skilled personnel with documented competence. All records to be available for NOV's or third-party review.

2 GENERAL REQUIREMENTS

The main IEC standards for assembly electrical and instrumental installations on machines are IEC 61892 series and IEC 60079-14.

This installation specification is a guidance for how the installation shall be performed for NOV equipment.

Final location of equipment shall be selected to avoid interference with escape routings, walkways, other equipment, pipes etc. and obstruction against activities to transport and lifting operations.

Equipment located in areas which do not allow for maintenance as required, should be installed on brackets which are arranged such that the equipment can be rotated, raised or lowered into areas where maintenance can take place without the need of scaffolding.

2.1 Reference standards

IEC 60079-0:2017, Equipment, General Equipment
IEC 60079-1:2014, Equipment protection by flameproof enclosures “d”
IEC 60079-14:2013, Electrical installations design, selection and erection.
IEC 60204-1:2021, Electrical equipment of machines
IEC 60533:2015, Electromagnetic compatibility (EMC).
IEC 61892-1:2019, General requirements and conditions.
IEC 61892-2:2019, System design.
IEC 61892-3:2019, Equipment.
IEC 61892-4:2019, Cables
IEC 61892-5:2019, Mobile units.
IEC 61892-6:2019, Installations.
IEC 61892-7:2019, Hazardous area.

3 CABLE SUPPORTS; LADDERS AND TRAYS

Cable ladder support, tray supports, bolts, nuts and washers shall be of stainless steel, AISI 316L or AISI 316. (IEC 61892-6, 6.8) unless otherwise specified in the PO documentation package.

Distance between cable ladders/tray support shall preferable be 1m,
with a maximum distance between the cable ladders/trays and support of 3m.
(IEC 61892-6, 6.8)

Cable ladders installed horizontally shall have minimum 300mm free space on top and enough space to facilitate pulling and cleating/strapping. (IEC 61892-6, 6.2)

All surfaces shall be cleaned prior to bolting together. (IEC 61892-6, 6.8)

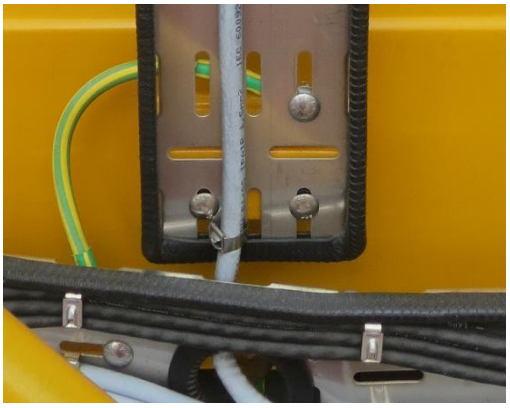
Sharp edges on cable ladders and trays where cables are crossing shall be protected by gasket edge list.

Equipment brackets, and junction box stands shall be from the same material as the cable support system in the area.

If support for cable ladders/trays is not of the same material as the ladders/trays, a Teflon washer shall be used between dissimilar metallic material to avoid galvanic corrosion.

Electrical continuity between cable ladders/trays shall be maintained by use of splices or bonding conductor.

If electrical continuity between cable ladders/trays cannot be maintained an additional bonding conductor shall be installed between cable ladders/trays and structure. (IEC 61892-6, 5.8)



Cable ladders/trays mounted in direct metallic contact with the unit structure need no supplementary bonding, provided that the surfaces in contact are clean and free from rust, scale or paint when installed and are firmly bolted together.

For mechanical protection of single field routed cables shorter than 5m, trunking or conduits with open ends may be used. (IEC 61892-6, 6.2)

Where cables are installed in horizontal pipes or the equivalent is used for cable protection, means of drainage are to be provided

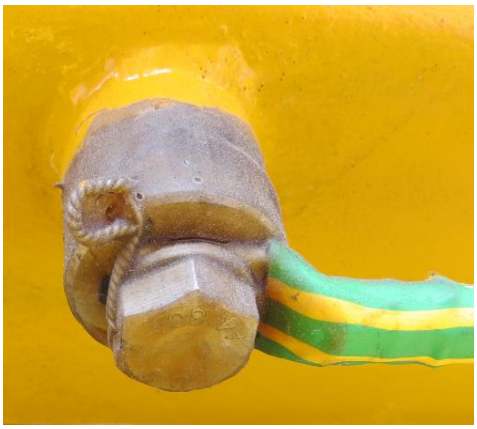
Protection shields shall be installed where cables can be exposed to physical damage. It shall be of same material as the cable support system and be installed up to minimum 500mm above the floor. (IEC 61892-6, 6.8)

Kick plate shall be fitted around penetrations in floor where cables/tubing are exposed to mechanical damages.
(IEC 61892-6, 6.8)

4 SYSTEM EARTHING

4.1 General

Earth bosses shall be made of stainless steel AISI 316 L.

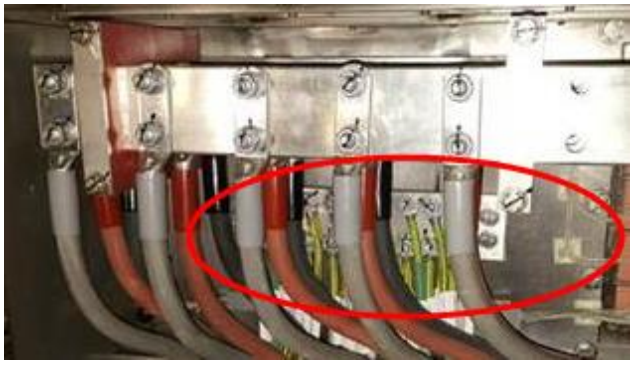


Earth bars shall be made from copper and provided to suit number and size of connections.

All earthing bars, earthing bosses and termination shall be visible and possible to check after termination of cables.

Separate connections shall be used for each individual earth conductor. (IEC 61892-6, 5.1.2)

Not acceptable placement for the earth bar and terminations:



Where earthing is not obtained through normal construction, extra arrangement to effectively earth metal structures of derrick and mast or other extraneous conductive part shall be provided.

4.2 Main earth

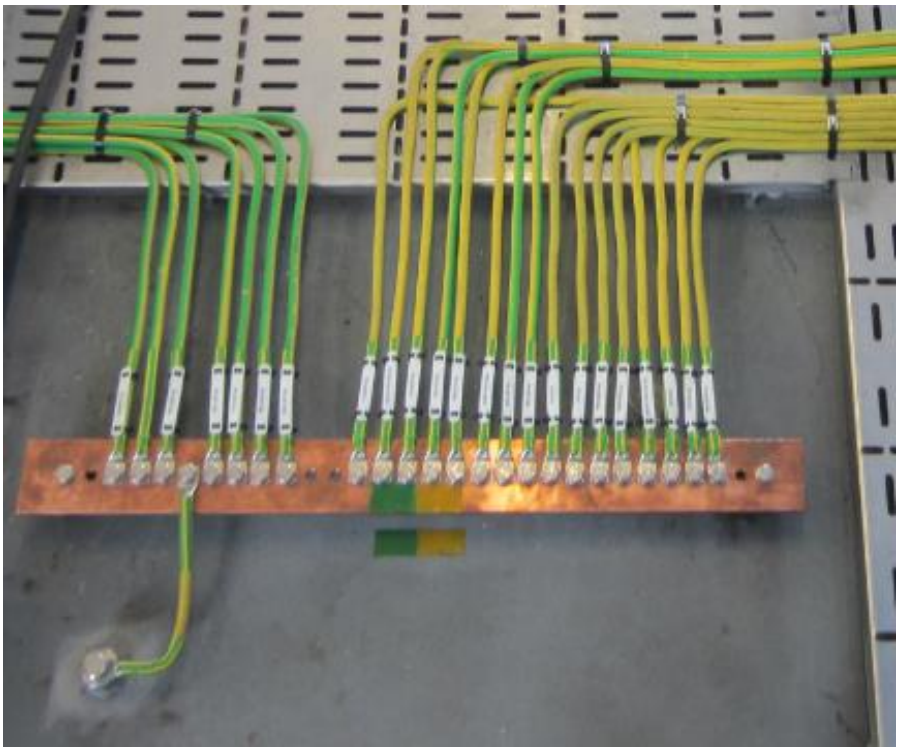
The main earth reference for all earthing systems shall be the main structure.

The main protective earth conductor (PE) shall be connected to main structure at one point only and it shall have a cross section area of min 25mm2.

Earth conductors shall be colored yellow/green.

The connection point shall be either:

1. One earth boss welded to the structure or;
2. An earth bar of copper connected to one or two earth bosses welded to the structure.

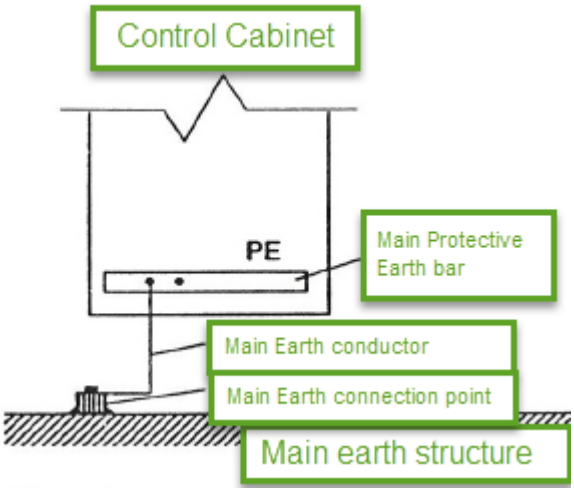


Main earth connections to earth bars, when provided, shall be easily accessible for usage, inspection and maintenance. (IEC 61892-6, 5.1.2)

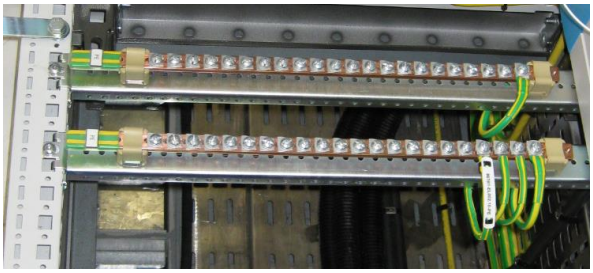
There shall be a separate main earth reference point for PE and IE.

4.3 Protective earth (PE)

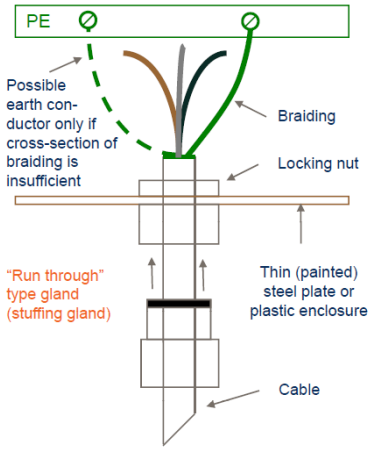
There shall be a main protective earth (PE) bar reference point established in the control cabinet. The main protective earth conductor from structure main earth point shall be connected to the PE bar.

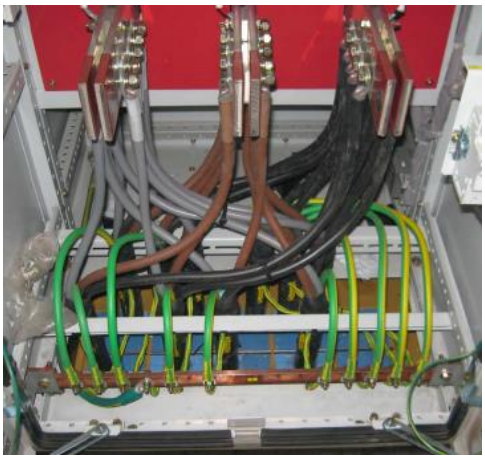


Field equipment shall be connected to protective earth bar in supply cabinet, through supply cable. The cable armour shall be used as the PE conductor. When cable armour does not have sufficient cross section, it shall be a separate PE-conductor included the supply cable.



Cable copper armour used as PE conductor shall be brought through the gland and be earthed inside the equipment enclosure.





Single core cables for 3ph AC shall run in trefoil formation. All cables shall have the same length. The braided armor shall be earthed in one end only.

For equipment installed in hazardous areas, the braid shall be earthed at the hazardous end. When using single core cables, additional cables for earthing shall be installed.
(IEC 61892-6, 6.2)

All metallic coverings, hence armor or braiding of cables shall be connected to PE terminal/bars at both ends, except for the provisions given for the single-core cable for AC wiring.
(IEC 61892-6, 5.7.1)

All metallic protective coverings of power and lighting cables passing through a hazardous zone, or connected to apparatus in such a zone, shall be earthed at least at their ends. The metallic covering of all other cables shall be earthed at least at one end. (IEC 61892-7, 9.4.2)

When use of double compression gland (Exd type), armor/braiding shall be terminated in gland. (IEC 61892-6, 5.7.2)

For equipment where the braid armor is ended in the gland and the voltage is above Safety Voltage (50VAC/120VDC), a separate earth conductor in the cable is required.

Metal enclosures or other exposed conductive parts that are a part of electrical equipment exceeding 50V DC or 50V AC shall be earthed by fixing the metal enclosure or conductive exposed parts in firm contact to the main structure (main earth potential) or by a separate earth conductor.

Electrical equipment that needs to be connected to protective earth shall be provided with suitable fixed terminal for connecting a protective earth conductor. The terminal shall be identified by a symbol ⏚ or text “PE” for protective earthing.

4.4 Instrument and intrinsically safe earth (IE/ISE)

If separate earth reference point for IE/ISE are provided they shall be welded to structure with a minimum distance of 1.0m or 3.5ft from the PE reference point.

When a control cabinet has combined or individual IE and ISE earth bars, these shall be connected to their respective main reference points, not PE.

A combined IE/ISE bar may be the earth reference for instrument (IE) and intrinsically safe (ISE) earth system.

When IE and ISE are separated by different earth bars:

- Intrinsically safe cables (IS) shall have screens connected to the IS earth bar. (IEC 61892-6, 5.7.10)
- Instrument cables shall have screens connected to the IE earth bar.

5 CABLES

5.1 General Requirements

All cables installed in hazardous areas shall be sheathed with a non-metallic impervious sheath in combination with braiding or other metallic covering for-mechanical protection.
(IEC 61892-7, 9.4.1)

Non-IS and IS instrument cables should be routed on the same cable ladders/trays. If routed on same ladder/tray, the IS and non-IS cables, which contain both armour and screen can be tied together in same bundle.

Once a cable has been cut and exposed to humid atmosphere, a protective cap/sealing shall be applied on the end. (IEC 61892-6, 6.2)

5.2 Cable Segregation

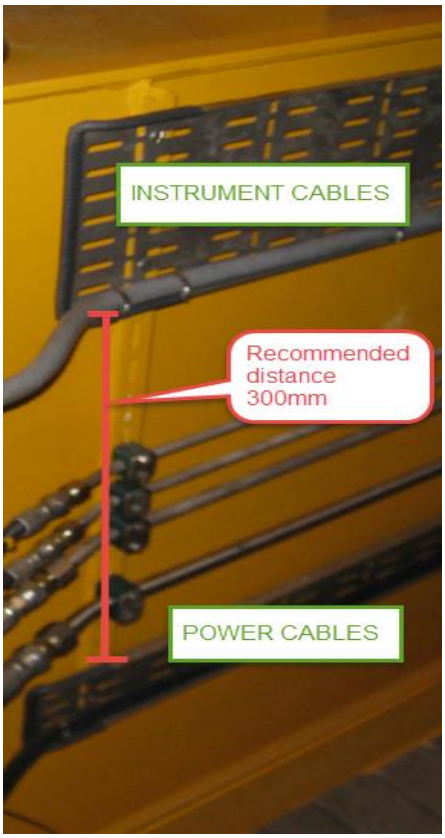
Recommended distance between low voltage, control and instrumentation cables is 300mm (1 ft). Cables for the different systems can be installed on same field tray from branch to single equipment.

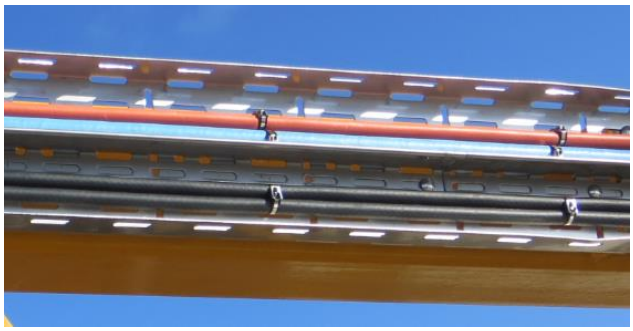
Cables for high voltage, low voltage, control and instrumentation shall not be installed on the same cable ladders or trays

Where insufficient space makes this impossible, cables for low voltage, control and instrumentation may be installed on the same tray, but not in the same cable bunch.
(IEC 61892-6, 6.2).

A partition separator made of the same material as the cable tray should be installed on the tray or ladder if different types of cables are installed on the same tray or ladder.
(IEC 61892-6, 6.2).

Crossing at right angle is acceptable without further segregation.





5.3 Cable bending radius

The internal bending radius for the installation of cables shall be as recommended by the manufacturer according to the type of cables chosen. (IEC 61897-4, 4.15)

Where cables are secured to equipment or cable trays, the bend radius on the cable should be in compliance with the cable manufacturer's data or be at least 8 times the cable diameter to prevent damage to the cable. (IEC 60079-14, 9.3.7)

Minimum cable bending radius referenced to manufactures installations guide:

Cable type	Minimum bending radius during installation	Minimum bending radius fixed installed
BFOU	8 x D	6 x D
RFOU		
BU		
UX		
BFOU VFD		
RFOU VFD		
RADOX TENUIS−TW/S EMC Cable D < 12 mm	6 x D	3 x D
RADOX TENUIS−TW/S EMC Cable D ≥ 12 mm	8 x D	4 x D
RADOX 125 Scr. Multicore cable		4 x D
Polyrad XT-125		7 x D
Ølflex FP 855		4 x D
Igus Chainflex CF78.UL		4 x D
PROFIBUS 6XV1830-0PH10	120 mm	60 mm
PROFIBUS DP2512	15 x D	10 x D
RG214 coaxial cable		5 x D
RG211 coaxial cable		50 mm
Hernis Multicable P/N-025108		170 mm
Hernis Multicable P/N-025122		188 mm
QFCI fiber-optical cable		250 mm

Note: Cables between moving constructions as crane frame and crane boom shall be within a minimum of 15 x D bending radius

Cables bends shall not have any wrinkles after installation.

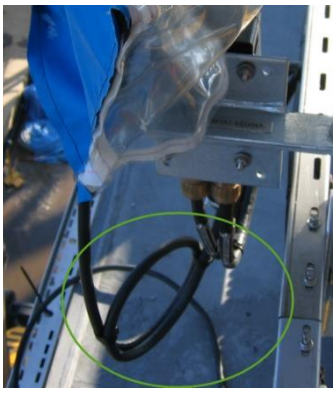
Not Acceptable

Acceptable

5.4 Cable installation

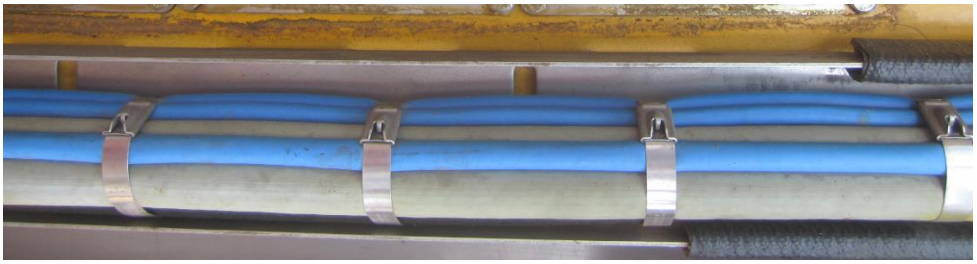
All types of cables for low voltage and instrumentation should be routed on cable ladders or trays.

Sufficient cable spare length shall be provided for equipment that needs future adjustments (floodlights, loudspeakers, etc.) or where equipment has to be dismounted for maintenance and calibration without disconnecting the cable. (IEC 61892-6, 6.2)



Stainless steel straps shall be used for all runs outside, in non-ventilated areas, or for horizontal runs in the vertical plane indoors. When cut, no sharp ends shall be left in cutting end.
(IEC 61892-6, 6.4)

Distance between cable straps shall not exceed 300mm (1 ft).



Plastic straps may be used for horizontal runs indoors. (IEC 61892-6, 6.4)
Stainless steel straps are to be preferred for all use indoor.

Cables shall be routed straight from the cable gland to avoid lateral tension that may compromise the seal around the cable. (IEC 61892-6, 6.7 & IEC 60079-14, 10.3)

The bend radius of the cable should start at least 25 mm (1 inch) from the end of the cable gland. (IEC 60079-14, 9.3.7)

Not Acceptable

Acceptable

Cable runs in hazardous areas should, where practicable, be uninterrupted. Where discontinuities cannot be avoided, the joint shall be in an enclosure with a type of protection appropriate to the zone. (IEC 61892-7, 9.3)

Where cables which may be expected to operate simultaneously are laid close together in a cable bunch in such a way that there is an absence of free air circulation around them, the following reduction factor is to be applied to the current rating.

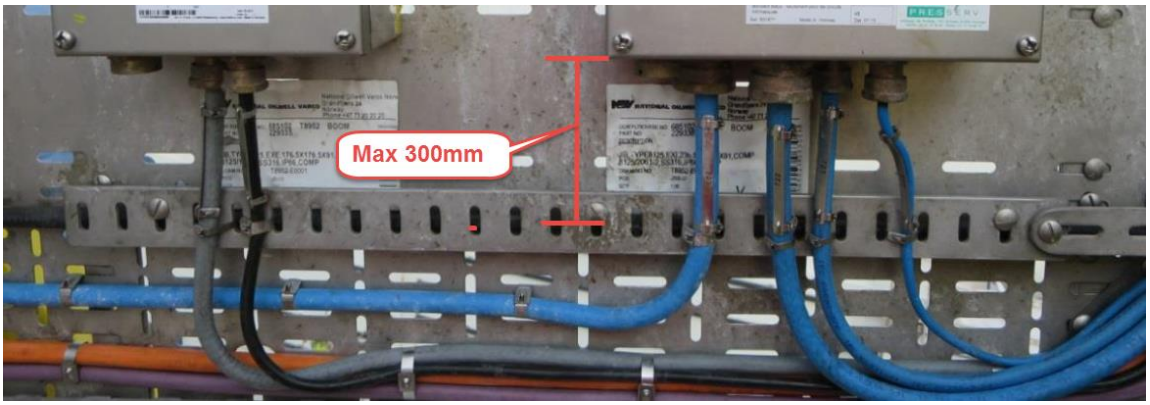
Number of Cables in One Bunch	*Reduction Factor*
One to six	1.00
Seven to twelve	0.85

5.5 Cable termination

All cable entries to equipment located outdoors, or in wash down areas shall be from below. Side entry may be used provided the cable is installed with a drip nose. (IEC 61892-6, 6.2)

If pulling and twisting forces on cable is transmitted to conductor terminations inside an enclosure a clamp shall be provided as close as practicable to the gland.
(IEC 60079-14, 10.3)

Cable clamps within 300 mm (1ft) of the end of the cable gland are preferred. (IEC 61892-6, 6.7 & IEC 60079-14, 10.3)

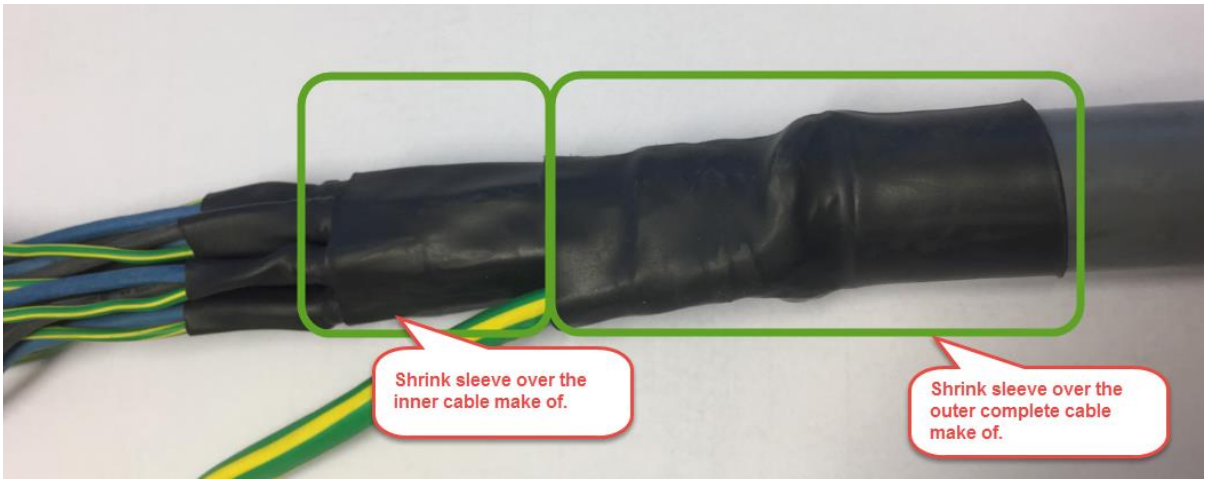


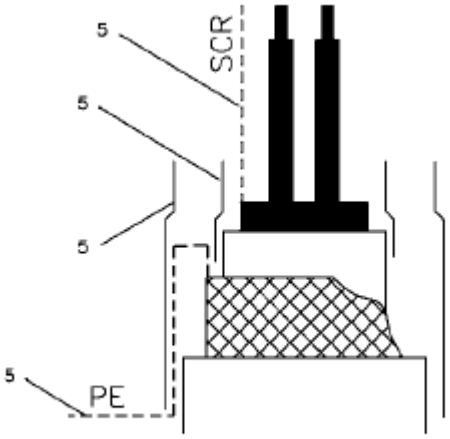
Note: Recommended distance from gland to 1st Cable clamps will be 10 X Cable Diameter

Cables with braid armour shall have outer additional insulation, e.g. a sleeve, which is fitted over the complete cable make-off. (IEC 61892-6, 6.7)

Cables with both braid armour and screen shall have inner and outer additional insulation. The outer additional insulation shall be fitted over the complete cable make-off. (IEC 61892-6, 6.7)

The inner additional insulation shall be drawn over the inner cable sheath, i.e. passed under the braiding providing insulation between braiding and screen.
(IEC 61892-6, 6.7)

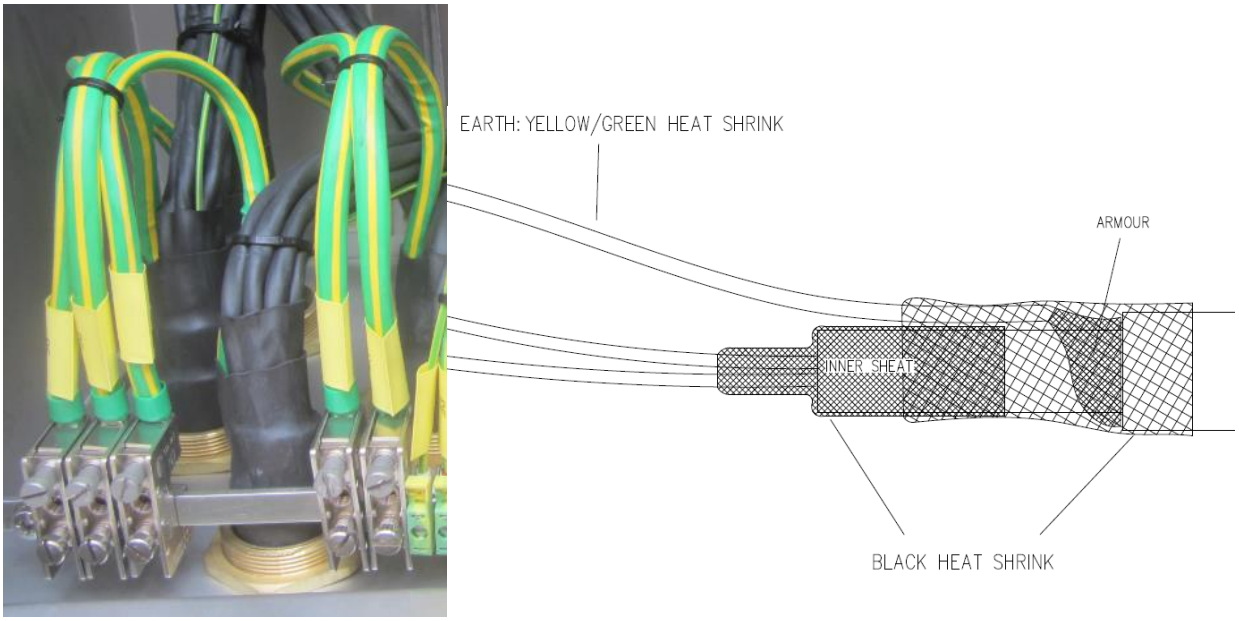




IEC 2945/13

Detail of heat sink isolation outer braid and screen

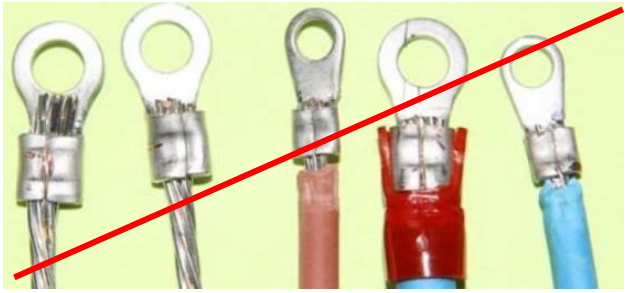
The braid armour and the screen shall be separated from each other as well as from the conductors and fitted as required. This shall be done without any reduction of the cross sectional area. The connection should, by preference, be with a 360° connection. Pigtails should be avoided. (IEC 61892-6, 6.7)



6 WIRING

6.1 Terminations

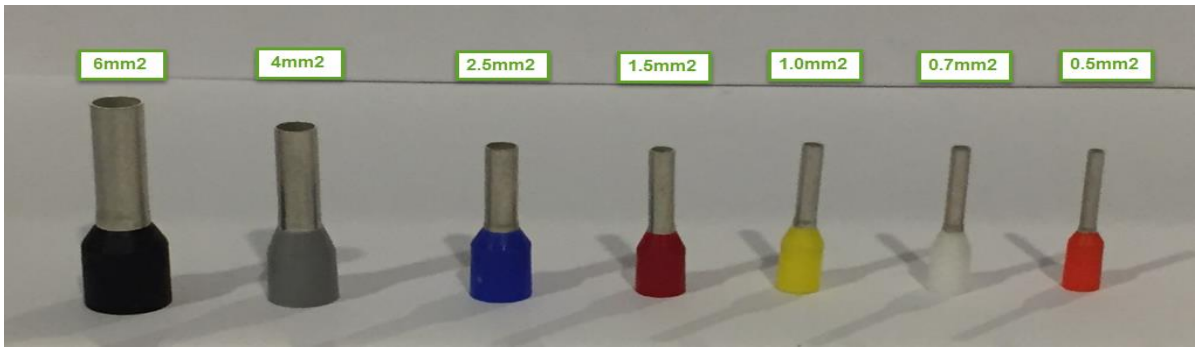
All cable conductors shall be terminated by use of compression lugs or ferrules dependent upon the type of termination, unless the terminal is of a type designed to be used without ferrules. The compression ferrule should be the type where the conductor strands are inserted through the whole ferrule and reach the bottom of the terminal. (IEC 61892-6, 6.7 / IEC 61892-7, 9.7.2 / IEC 60079-14, 9.6.2)

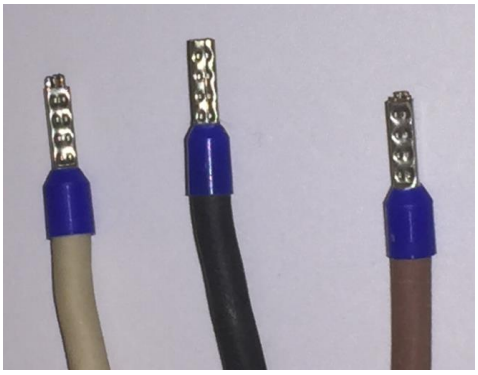


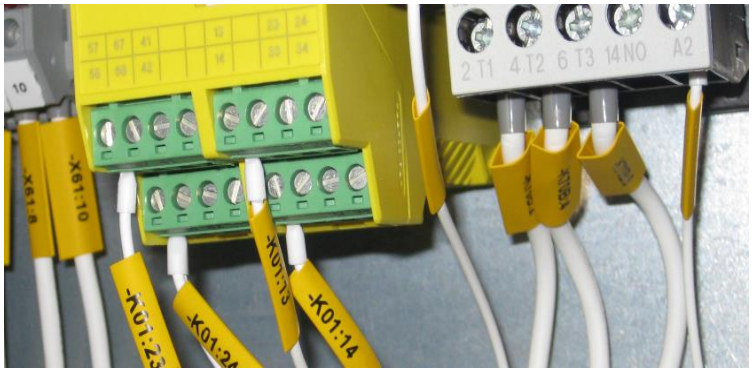
Preferred Type (tubular type)

Not preferred type (only to use in small spaces)

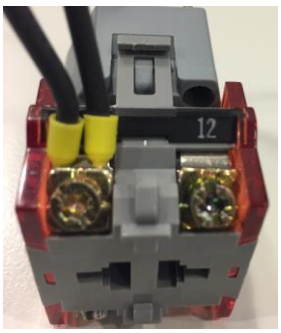
6.2 Ferrules



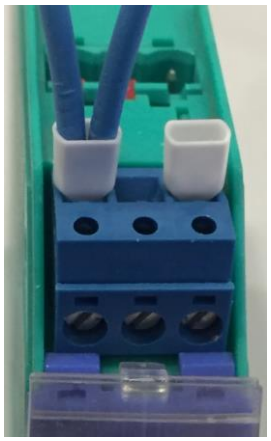




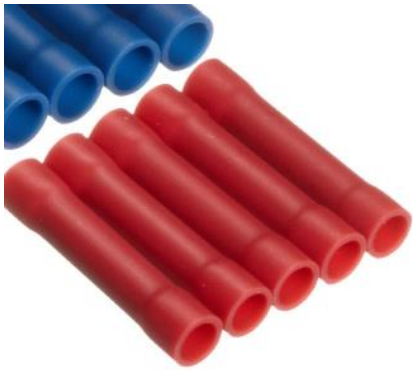
Only one conductor shall be connected to each terminal of a terminal block/row for external connections. This is not related to terminals approved for two conductors for internal components (e.g. relays, contactors). (IEC 61892-6, 6.7)



For internal connections inside cabinets, two conductors can be terminated to the same terminal by use of a double ferrule.

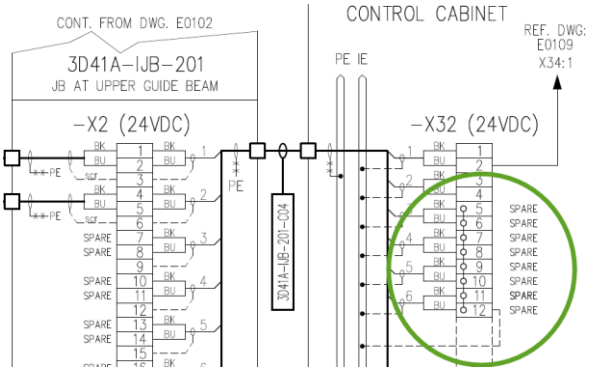


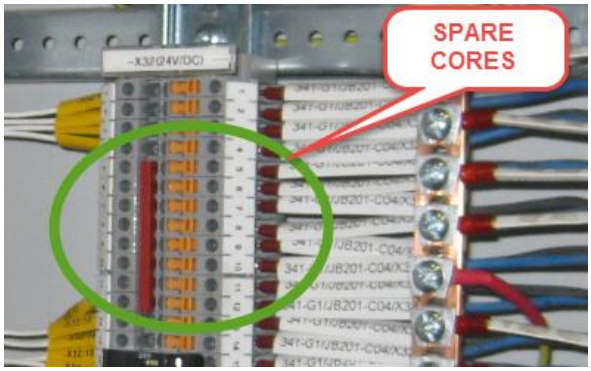
Where the screen shall be left disconnected (applicable for field instrument) it shall be sealed and isolated with an isolating cap, which allows for insulation testing without any disconnecting. (IEC 61892-6, 6.7)



6.3 Spare conductors

In cabinets all spare conductors shall be marked with a terminal number and connected to terminals linked together by solid terminal links, which shall be connected to the relevant earth bar. (IEC 61892-6, 6.7)





If there are no spare terminals left in the cabinet, all spare conductors shall be covered with yellow/green sleeves and marked with relevant cable number and connected directly to the relevant earth bar. (IEC 61892-6, 6.7)

Spare conductors in instrument and telecom cables shall be isolated at the field and connected to IE or IS earth (instrument or intrinsically safe earth) at the source end. (IEC 61892-6, 6.7)
Spare conductors in power cables shall be terminated, connected to PE-bar at both ends.

In hazardous area the end of each unused core in multi-core cables shall either be connected to earth or be adequately insulated by means of terminations suitable for the type of protection. Insulation by tape alone is not permitted. (IEC 60079-14, 9.6.3 / IEC 60079, 9.7.3)

In junction boxes spare conductors shall be connected to terminals.

The length of **spare conductors** shall be sufficient to reach all terminations within enclosure

7 BRACKETS

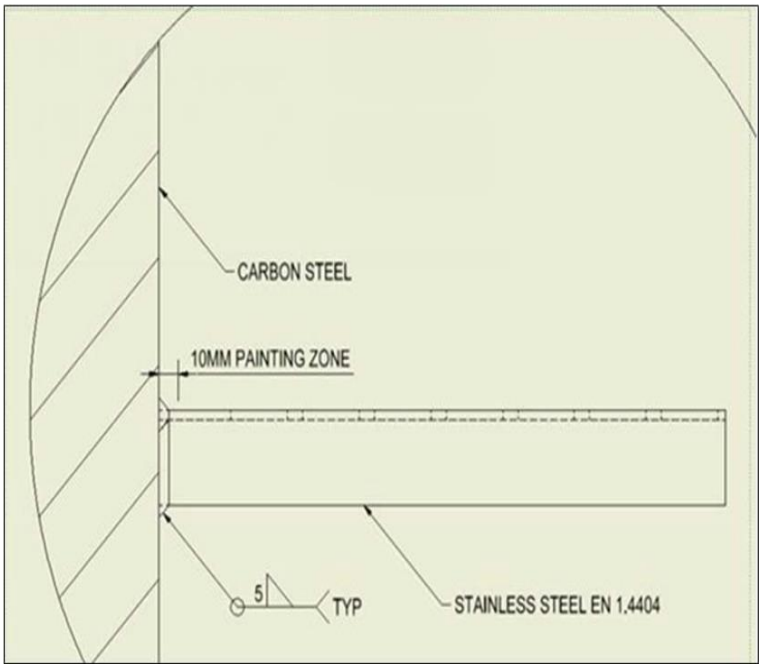
All brackets and supports for cable tray, junction boxes, lighting fixtures and other electrical equipment are to be in the Supplier's scope of work. Brackets etc. to be installed according to drawing or after instruction from NOV.

The Supplier is responsible for contacting NOV when brackets etc. are to be installed. This must be done minimum five days prior to surface treatment.

8 PAINTING STAINLESS STEEL SUPPORT FOR E&I

Surface treatment shall be according to specified coating system. The finished coat shall cover minimum 10mm over the HAZ on the Stainless Steel support.

Note: The contact surface on top of the angle shall not be painted, but must be covered during blast cleaning.



8.1 Touch-up paint

All touch-up work resulting from installation of brackets etc. and from electrical installation is to be included in Supplier's scope of work.

9 ELECTRIC HOOK-UP ARRANGEMENT

Measures to avoid galvanic corrosion shall be taken

Before power is switched on, the supplier is responsible for checking the items as described in the template from annex 1. The supplier is responsible for record with the inspector signature or NOV electrical supervisor.

10 ANNEX 1

Date: _____

Location: _____

PO No: _____

Serial Number: _____

	Electrical Hook-up arrangement	Yes	No	Comments	Sign
1	**Main power supply cables are properly sized for NOV equipment connected for test.**	☐	☐		
2	**Size and setting for vendors/facility main circuit breaker / switch is appropriate according to the connected cables and equipment.**	☐	☐		
3	**There shall be access to main vendors/facility circuit breaker / switch in case of an emergency. If not, there shall be a nearby located Emergency stop button for main power shutdown**	☐	☐		
4	**If in doubt, contact NOV electrical supervisor for facility related questions and/or NOV electrical project engineer for equipment related questions.**	☐	☐		
5	**Visual inspection of all test cables and no mechanical damage allowed**	☐	☐		
6	**Power cable must be insulation tested**	☐	☐		